REMARKS

I. Amendment of the Claims

Claims 1-3, 6, 59, 60, 67, 68, and 72 have been amended for purposes of clarification. No new matter is introduced by the amendment. Specifically, support for the term "additional", which is included to further describe the polycrystalline silicon that is to be intermittently fed throughout the claims, is found in the specification at, for example page 10, lines 15-20 and page 13, lines 5-9. Additionally, support for the inclusion of the phrase "in the crucible from which the single crystal silicon ingot is grown" in the last sub-paragraph of the independent claims is found, for example, in the preamble of each respective independent claim and in the specification at page 22, lines 3-14, which discloses using the method of the present invention to recharge a crucible having a melted charge depleted by pulling a crystal, and page 10, lines 6 and 23, which refer to loading the CZ crucible (i.e., the crucible from which an ingot is grown by the Czochralksi method).

II. Information Disclosure Statement

Enclosed herewith is a supplemental Information Disclosure Statement resubmitting reference 13, DE 4201546, Klöpsch et al., with an English Abstract. Also, enclosed is a check for an amount that includes the appropriate fee set forth in 37 C.F.R. 1.17(p).

III. 35 U.S.C. 112

A. Wedge Angle

Reconsideration of the rejections of claims 37-51, 60, and 86-89 based on 35 U.S.C. 112, first and second paragraphs regarding the term "wedge angle" is respectfully requested.

Applicant submits that the term "wedge angle" is clear and satisfies the requirements of section 112, second paragraph because requiring a wedge angle of about 180° in claim 37, does not make the term "wedge angle" unclear. Although the term "wedge" may be used to describe a block of solid material having a v-shaped cross section, the applicant is using the term in a manner that is similar to and/or consistent with the graphical depiction of data in the form of a pie chart. Specifically, the applicant is describing the pattern in which polycrystalline silicon is deposited on the unmelted portion of a partially melted charge when viewed from above the melt surface. When viewed from above, the interface between the melted and unmelted silicon in the crucible preferably appears to be substantially circular.[1] Further, as described throughout the specification, including FIGS. 8-10, the deposition of the polycrystalline silicon on the unmelted portion of the charge is controlled so that polycrystalline silicon is deposited in an intermittent manner while rotating the crucible so that each intermittent deposit generally looks like a wedge of a circle or pie chart.

In view of the foregoing, the specification of the application adequately describes the term "wedge angle" so that its meaning is clear. Therefore, the use of the term particularly points out and distinctly claims the subject matter of the invention in accordance with § 112, second paragraph. Although the applicant's use of the term "wedge angle" may not by typical, MPEP 2173.05(a) allows for a term to be used in a manner different from its ordinary meaning provided the written description clearly defines the term. According to *Process Control Corp v. HydReclaim Corp.*, 190 F3d 1350, 1357, 52 USPQ2d 1029, 1033 (Fed. Cir. 1999), all that is required to satisfy section 112, second paragraph is that the term be described in the specification "so as to put a reasonable competitor or one reasonably skilled in the art on notice that the patentee intended to so redefine that claim term." Referring to FIGS. 2 and 3 of the

[1]Application as submitted (hereinafter "Application") at page 17, lines 18-22 or application as published, US 2003/0101924 A1, (hereinafter "Publication") at paragraph 44.

application, a "wedge" is defined as the portion of the unmelted charge upon which the polycrystalline silicon is deposited "that extends radially outward from about the center 12 of the unmelted polycrystalline silicon to the interface 61 between unmelted polycrystalline silicon and the upper surface of the molten silicon." Further, the term "wedge angle" is the angle of the wedge near the central axis 50 of the crucible and/or the center 12 of the unmelted polycrystalline silicon that is determined by the rotation rate of the crucible and the length of time the polycrystalline silicon is fed during the on period.[2] Additionally, as set forth in page 17, lines 4-22 and Table A of the application, the wedge angle, although preferably less than about 180°, may be about 180°, which results in a wedge corresponding to about one-half of the circle (i.e., a semicircle). Thus, the fact that the wedge may have a wedge angle of about 180° does not render the term "wedge angle" unclear. Rather, the specification clearly defines the term in accordance with § 112, second paragraph. Also, the subject matter is described in the specification in a manner that enables one of skill in the art to use the invention as required by section 112, first paragraph.

B. Multiplicity of wedges

Reconsideration of the rejection of claims 52-58 based on 35 U.S.C. 112, first and second paragraphs regarding the multiplicity of wedges is respectfully requested.

As described above, and in more detail in the specification at page 15, line 8 to page 18, line 25 (US 2003/0101924 A1, paragraphs 39-45), the polycrystalline silicon is intermittently deposited in such a manner that, when viewed from above, the deposits appear similar to a wedge of a pie chart. Claim 52 specifies that each wedge does not substantially overlap with the preceding wedge. Claims 53-58 provide further details such as when deposition on a particular wedge is repeated, relative locations of

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[2]Application at page 17, lines 4-17 or Publication at paragraph 43.

wedges, and the times of depositions with respect to crucible rotation. Thus, it is clear that there is a multiplicity of wedges. FIG. 7 does not imply that previous or subsequent wedges have not or will not be deposited. As set forth above, the deposition of a wedge occurs over a particular period of time, as such, FIG. 7 is illustrating an instant during the deposition of a wedge. Specifically, "FIG. 7 is a *section* showing a subsequent *on period* of the intermittent feed process of the present invention . . . ."[3] Thus, the fact that FIG. 7 is only depicting the act of forming a single wedge, rather than multiple wedges, is necessitated by the fact that in the depicted embodiment each wedge is formed singularly (i.e., in the embodiment depicted in FIG. 7, deposits on different wedges do not occur concurrently). For a depiction of deposition patterns that contain multiple wedges, the applicants direct the Examiner to FIGS. 8-10. In view of the foregoing, the claims properly refer to multiple wedges and FIG. 7 does not contradict the multiplicity of wedges set forth in the claims. Therefore, the multiplicity of wedges is clearly defined in accordance with § 112, second paragraph and one of skill in the art has been advised on how to use the invention as required by section 112, first paragraph.

C. No Substantial Overlap of Wedges

Reconsideration of the rejection of claims 52-58 based on 35 U.S.C. 112, first paragraph regarding the no substantial overlap of wedges element is respectfully requested.

In addition to the § 112 rejection, the comments regarding FIG. 6 and the rejection of 36-52 for obviousness (the paragraph beginning on page 7 and continuing to page 8 of the Office action) indicate that the Examiner may be misinterpreting the

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[3] Application at page 9, lines 25-27 or Publication at paragraph 24, *emphasis added*.

polycrystalline silicon chunks depicted in FIG. 6 and Holder FIG. 3 as wedges. The foregoing discussion regarding the meaning of the term "wedge" should resolve this misunderstanding. Specifically, a "wedge" is a portion of the surface upon which the polycrystalline silicon is deposited during a particular on-period. Further, claims 52-58 require that the deposition of polycrystalline silicon be controlled in such a manner (e.g., by the on- and off-period durations and the crucible rotation) that there is not "substantial overlap" (e.g., less than 30% overlap) between the portion of the exposed unmelted polycrystalline silicon upon which polycrystalline silicon is currently being deposited and the portion of the surface upon which polycrystalline silicon was deposited during the immediately preceding on-period.[4] In view of the foregoing, it is clear what is meant by substantial overlap and that physical dividers are not necessary to prevent substantial overlap of wedges.

IV. NONOBVIOUSNESS OF CLAIMS

Reconsideration of the rejection of claims 1-96 based on 35 U.S.C. 103(a) as being unpatentable over Takase (U.S. 6,423,137) or Takase (WO 99/46433) in view of Holder (U.S. 5,588,993) and Nagai et al. (U.S. 5,902,395) is respectfully requested.

A. Nonobviousness of the Intermittent Delivery of Polycrystalline Silicon Onto Unmelted Polycrystalline Silicon in a Crystal Growth Crucible

Claim 1 is directed to a process for preparing a silicon melt in a crucible. Specifically, the process requires "intermittently delivering" additional polycrystalline silicon "onto the exposed unmelted polycrystalline" of a "partially melted charge in the

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[4]Application at page 18, lines 15-25 or Publication at paragraph 45.

crucible" to form the silicon melt "in the crucible from which the single crystal silicon is grown."

In rejecting this claim, the Office has cited Takase for the concept of intermittently feeding raw material into a crucible; Holder is cited for the concept of using chunk polycrystalline silicon, and/or for feeding solid polycrystalline silicon onto the exposed unmelted polycrystalline silicon from the initial charge; and Nagai et al. is cited for the concept of rotating the crucible. The Office asserted that it would have been obvious "to modify Takase with Holder's chunk polycrystalline silicon," and obvious "to modify the combination of Takase and Holder with Nagai's rotating crucible to prevent clogging the feed pipe."

Takase discloses feeding solid polycrystalline silicon into an <u>auxiliary crucible</u> where it is melted and eventually delivered in the molten state via a pipe to the main crucible to form a melt from which an ingot may be grown. In contrast, applicant's claim 1 is directed to "preparing a silicon melt in a crucible for use in growing a silicon ingot" and requires "feeding additional polycrystalline silicon into the rotating crucible ... [and] ... melting ... to form the melt in the crucible from which the single crystal silicon is pulled." Because Takase feeds polycrystalline silicon only into an auxiliary crucible in which it is melted, and does not feed polycrystalline silicon into a crucible from which a single crystal silicon is pulled, the proposed modification of incorporating Holder's polycrystalline silicon and Nagai et al.'s rotation would yield a process of feeding polycrystalline silicon into a rotating auxiliary crucible. The molten silicon would then overflow from Takase's modified rotating auxiliary crucible into the crystal-pulling crucible. Accordingly, the proposed modification would yield a process which fails to meet the requirements of "feeding additional polycrystalline silicon into the rotating crucible ... [and] ... melting ... to form the melt in the crucible from which the single crystal silicon is pulled." Applicant therefore requests withdrawal of the rejection because the proposed modification fails to teach or suggest the requirements of claim 1.

Moreover, even if a combination of Takase, Holder, and Nagai et al. were to present all the requirements of claim 1, this combination cannot be maintained because there is no motivation to modify the Takase process as proposed or to combine the disparate teachings of the references. MPEP 2143 specifically requires that there "<u>must</u> be some suggestion or motivation . . . to modify the reference or to combine reference teachings."[5] The reason for Takase's intermittent delivery is to reduce the time of contact of molten silicon with the inner wall surface of the pipe leading from the auxiliary crucible to the growth crucible, thereby eliminating the need for heating or insulation of the pipe:

> . . . raw material is fed from the feeder 21 intermittently, and not continuously, so that the melt in the auxiliary crucible 1 overflows intermittently to increase the overflow quantity. Thus, by reducing the time of contact with inner wall surface of the pipe 1a, the raw material is supplied to the main crucible 11. Col. 4, lns. 52-56.

> . . . additional raw material is intermittently supplied into the auxiliary crucible so that the melt in the auxiliary crucible intermittently overflows into the opening on the upper end of the feeding pipe and the overflow quantity is increased . . . . As a result, there is no need to provide heating means such as heater or heat keeping means such as heat insulating material on outer periphery of the feeding pipe, and it is possible to prevent solidification of the melt in the feeding pipe. Col. 6, lns. 10-24.

The reason for Takase's intermittent feeding is therefore germane to the fact that molten silicon prone to solidification is traveling through a feed tube. If Takase's process were modified as proposed such that solid or chunk polycrystalline silicon were being fed into the growth crucible, there would be no associated risk of solidification in the feed tube. With the problem of solidification in the tube rendered moot, Takase's basis for intermittent feeding is eliminated. Stated another way, any solution to the

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[5]Emphasis added

problem of molten silicon solidifying in a feed tube to a growth crucible is wholly irrelevant to a process involving feeding solid silicon into a growth crucible. Accordingly, there is no motivation to combine the respective references, and if one were to so combine them even without such motivation, there would be no motivation to employ intermittent feeding in the resultant combination. Claim 1 is therefore further patentable because the references lack any motivation or reason to use interrupted flow in connection with the flow of solid silicon into a growth crucible as required in claim 1.

In contrast to the reason for intermittent feeding in the Takase process, the applicant has discovered that intermittent feeding polycrystalline silicon allows for a crucible to be charged/recharged substantially quicker than by continuous feeding, which increases throughput and decreases production costs. For example, continuously feeding silicon, in accordance with the method disclosed by Holder, results in a relatively slow feed/melt rate of 8-12 kg/hr.[6] For example, the intermittent process set forth in applicant's Example 1 achieved a feed rate as high as about 19.2 kg/hr.[7]

With further regard to the proposed modification, it is also significant that Nagai et al.'s motivation for rotating their crucible is to promote continuous, not intermittent, feeding into the growth crucible; and in this regard they specifically teach away from intermittent feeding directly into a rotating crystal growth crucible:

> If the crucible is not rotated, the feeding of the granular silicon material to the unmolten layer through the feed pipe becomes intermittent, so that there continues a state in which the granular silicon material does not move in the feed pipe and eventually becomes melted, which may result in clogging of the feed pipe. However, rotation of the crucible makes it possible to continuously feed the granular silicon material to the unmolten layer. Accordingly, the granular silicon material can be constantly placed in a state in which it always moves in the feed pipe, which in turn makes it possible to prevent clogging of the feed pipe. Col. 6, ln. 2 ff.

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[6]Application at page 3, line 26 to page 4, line 9 or Publication at paragraph 7.

[7]Application at page 24, line 6 or Publication at paragraph 61.

The Office did not cite Nagai et al. for teaching whether feed to the growth crucible should be continuous or intermittent. Nagai et al. was cited for its teaching of a rotating crucible. However, the above-quoted teaching is significant because the motivation for Nagai et al.'s rotation is to avoid intermittent feeding. Accordingly, one skilled in the art would not be motivated to make the proposed combination; and the combination proposed is a result of picking and choosing selected concepts from the prior art with 20/20 hindsight using applicant's claims as a guide. As such, claim 1 is patentable because the proposed combination cannot fairly be deemed to be motivated by the prior art in addition to the fact that the proposed combination fails to teach or suggest all the requirements of the claim.

Claims 2-35 are patentable for the same reasons as claim 1 and for the additional elements recited therein. Additionally, with respect to claim 35, the Office stated that FIGS. 2 and 3 of Holder disclose a spray-type feed tube. This assertion is incorrect. Figures 2 and 3 of Holder disclose a vertical-type feed tube. A spray-type feed tube is depicted in FIGS. 6 and 7 of the Application and is described at page 16, line 23 to page 17, line 3 of the Application (Publication at paragraph 42).

B. Nonobviousness of Depositing Polycrystalline Silicon on a Wedge of Unmelted Polycrystalline Silicon.

Claim 36 requires that the portion of the exposed unmelted polycrystalline silicon upon which granular polycrystalline silicon is delivered be a wedge that extends radially outward from about the center to the interface between the unmelted polycrystalline silicon and the upper surface of the molten silicon. None of the cited references discloses depositing the polycrystalline silicon onto a wedge of unmelted polycrystalline silicon. Takase discloses adding molten silicon from an auxiliary crucible into a growth crucible containing molten silicon, not onto unmelted polycrystalline silicon. Figures 2 and 3 of Holder depict silicon being deposited over the center of an unmelted charge

and this randomly disperses the silicon over the entire surface instead of confining the deposited silicon to a wedge. Nagai et al. disclose a continuous flow of silicon which does not deposit the silicon on a wedge that extends radially outward from about the center of the unmelted polycrystalline silicon to the interface between unmelted polycrystalline silicon and the upper surface of the molten silicon.[8] Thus, none of the cited references discloses, teaches, or suggests controlling the deposition pattern of polycrystalline silicon in a manner so that the deposited material resides on a wedge of the unmelted polycrystalline surface as required by claim 36. As such, claim 36 is nonobvious and patentable.

Claims 37-51 are patentable for the same reasons as claim 36 (from which they depend) and the additional elements recited therein (i.e., the claimed wedge angles).

C. Nonobviousness of Depositing Polycrystalline Silicon So That There Is No Substantial Overlap Between Each Wedge and The Immediately Preceding Wedge

Claims 52-58 are patentable for the same reasons as claim 36 (from which they depend) and the additional elements recited therein. Specifically, claim 52 requires that there be no substantial overlap between each wedge and the immediately preceding wedge. Claim 53 requires that granular polycrystalline silicon be deposited on the entire exposed unmelted polycrystalline silicon prior to redepositing granular polycrystalline silicon on any wedge. Claims 54-57 depend from claim 53 and set forth the placement of deposits with respect to particular locations (i.e., wedges) and crucible rotation. Claim 58, in contrast to claim 53, requires granular polycrystalline silicon to be redeposited on a wedge prior to the depositing granular polycrystalline silicon on the entire exposed unmelted polycrystalline silicon. None of the cited references, however,

[8]Application at page 17, lines 4-17 or Publication at paragraph 43.

discloses controlling the feeding of polycrystalline silicon into a crucible in a manner which prescribes intervals between the redeposition of polycrystalline on a particular portion of the unmelted polycrystalline surface or the locations of subsequent deposition areas. As such, claim 52-58 are nonobvious and patentable.

D. Claims 59-96

Claims 59-96 are patentable for the same reasons as set forth for claim 1 and for the additional elements therein such as those discussed above regarding claims 36-58.

E. Claims 97-102

New claims 97-102, which depend from claims 1-3, 59, 60, and 68, respectively, further set forth the step of "growing a single crystal silicon ingot by the Czochralski method from the silicon melt in the crucible." As set forth in the independent claims, which are described in detail above, this silicon melt is formed by feeding polycrystalline into "the crucible from which the single crystal silicon ingot is grown." Takase, however, does not grow a single crystal silicon ingot from the crucible to which solid polycrystalline silicon is fed, because in Takase's process solid polycrystalline is fed only to an auxiliary crucible. As such, these claims are further patentable over the cited references.

Favorable consideration and allowance of claims 1-96 is respectfully requested.

Enclosed herewith is a check in the amount of $398.00 in payment of the fees for a one-month extension to reply, for the six claims added by this amendment, and for the enclosed supplemental information disclosure statement.

The Commissioner is hereby authorized to charge any additional fees which may be required to Deposit Account No. 19-1345.

Respectfully submitted,

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